Using Paleo-Reconstructions for Climate Change Vulnerability Assessments

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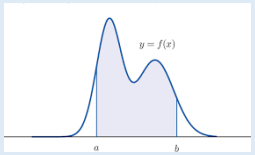
(formally of

California Department of Water Resources)

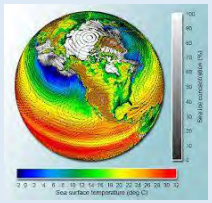
Collaborative project between:

- **DWR-Climate Change Program and**
- **University of Massachusetts-Amherst Hydrosystems Research Group.**

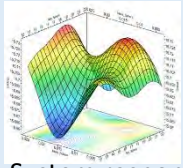
Bottom Up Systems Analysis



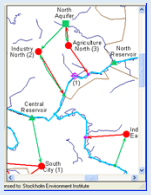
System performance prediction



Climate Model Ensemble



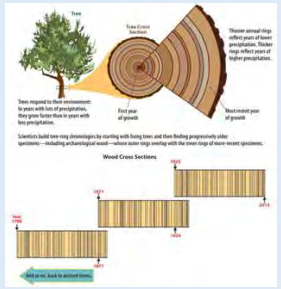
System response surface



Operations and Planning Models (CalLite)

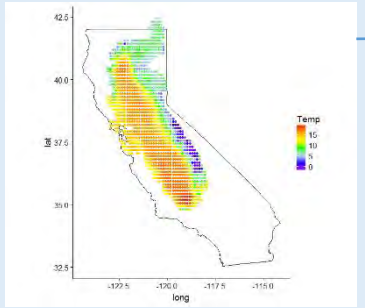
Using the Best Available Information from Multiple Sources

- Paleo Dendro-chronology Data



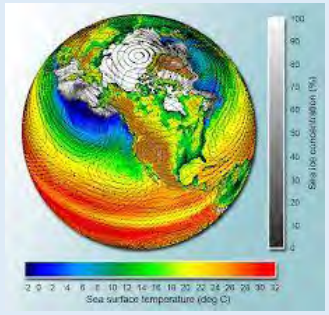
→ Inter-annual variability, quasi-cyclic and whiplash behavior

- Observational Meteorological Data

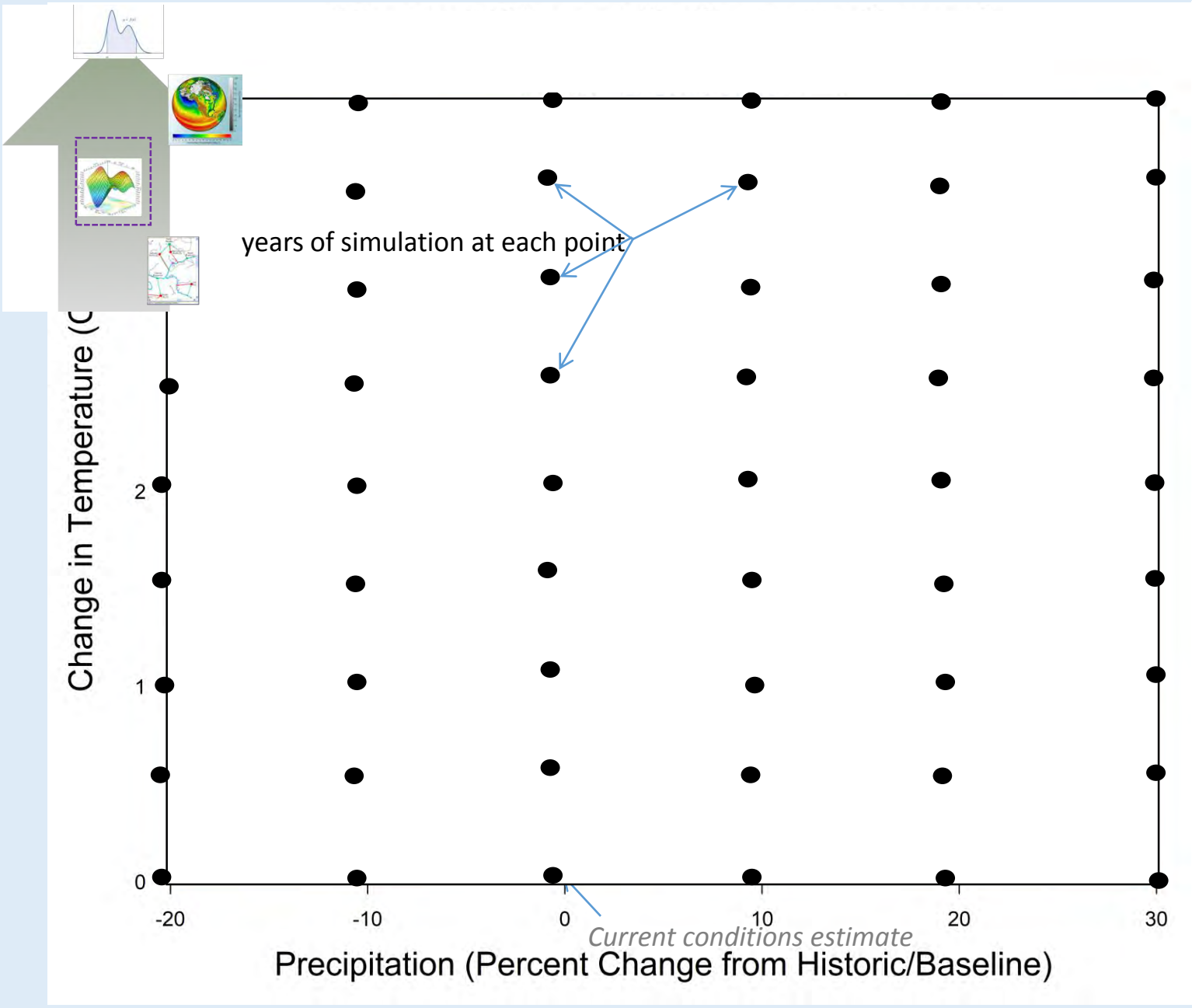


→ Spatio-temporal distribution of temperature and precipitation

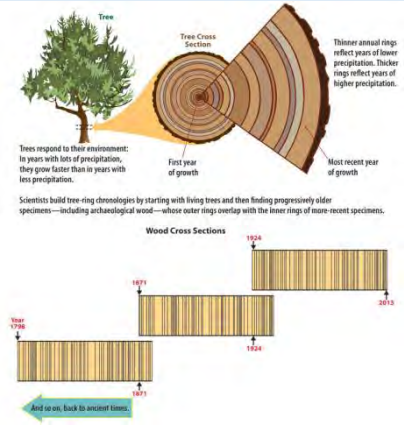
- Global Climate Model Data



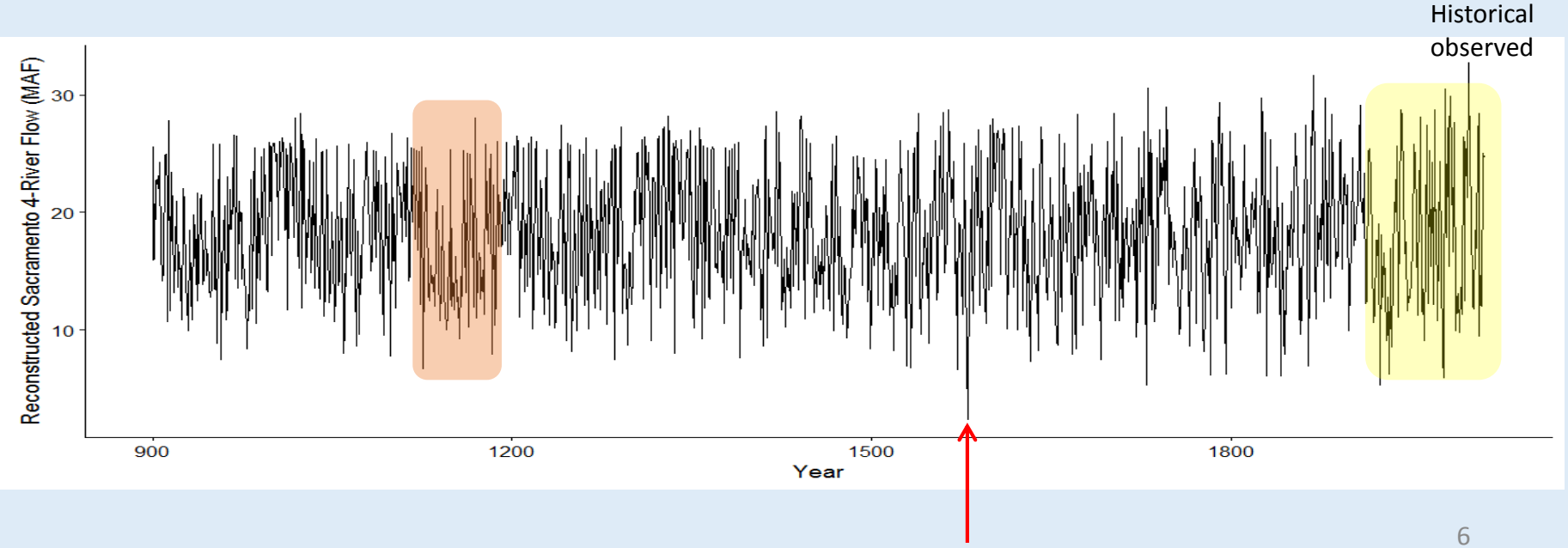
→ Large scale changes in average climate conditions

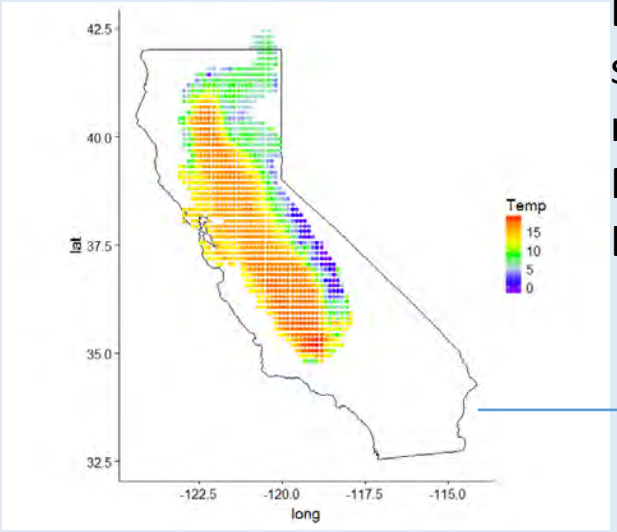

years of simulation at each point
Change in Temperature (C
0
1
2
-20
-10
0
10
20
30
Current conditions estimate
Precipitation (Percent Change from Historic/Baseline)

Long-term Inter-annual Variability from Paleo Dendrochronologies

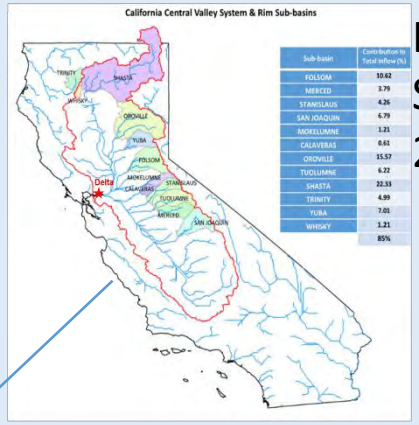


San Joaquin/Sacramento Hydroclimate Reconstructions from Tree Rings. Meko et al. 2014





Livneh daily CONUS near-surface gridded meteorological data- NOAA Earth System Research Laboratory

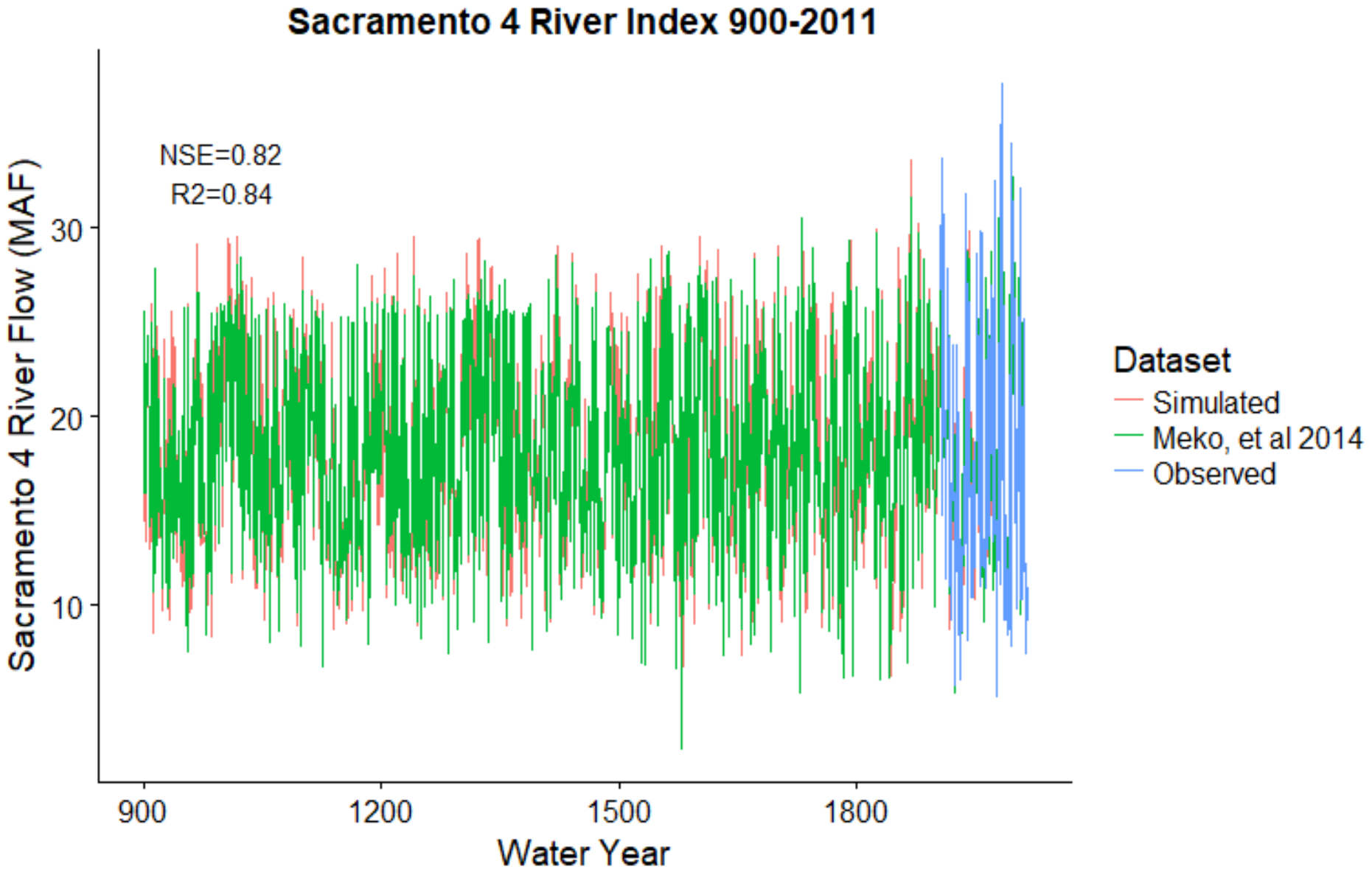


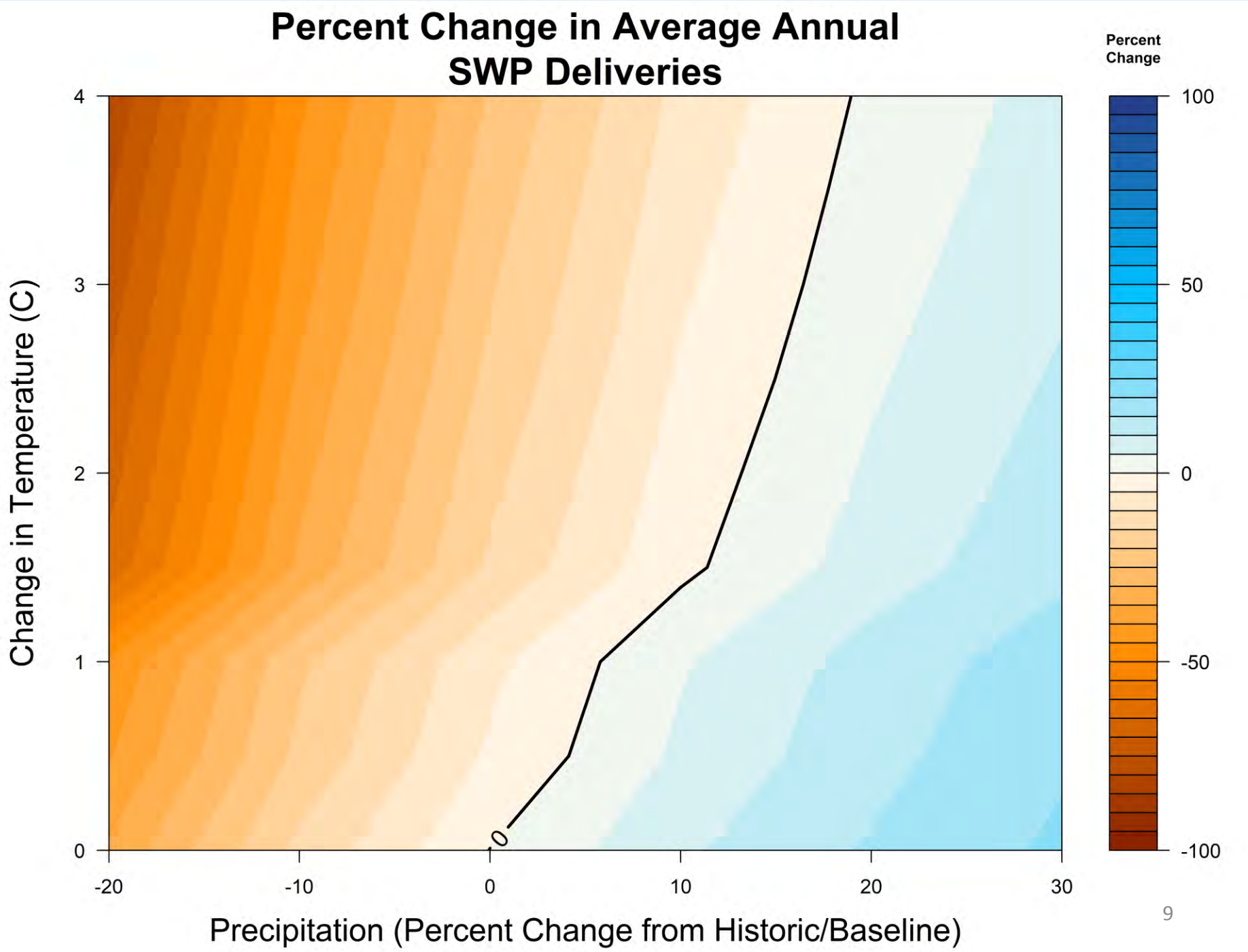
Historical Annual Streamflows (1950-2012)

Assign closest historically observed analogue year to each flow value of the 1,100 year reconstructed flows

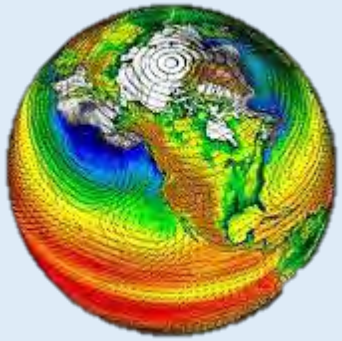
Assign analogue historical year gridded meteorology to each year of 1,100-year reconstruction

Create 1,100-year gridded meteorology record that can be used for planning/ simulation


Sacramento 4 River Index 900-2011
NSE=0.82
R2=0.84
Sacramento 4 River Flow (MAF)
30
20
10
900
1200
1500
1800
Water Year
Dataset
Simulated
Meko, et al 2014
Observed

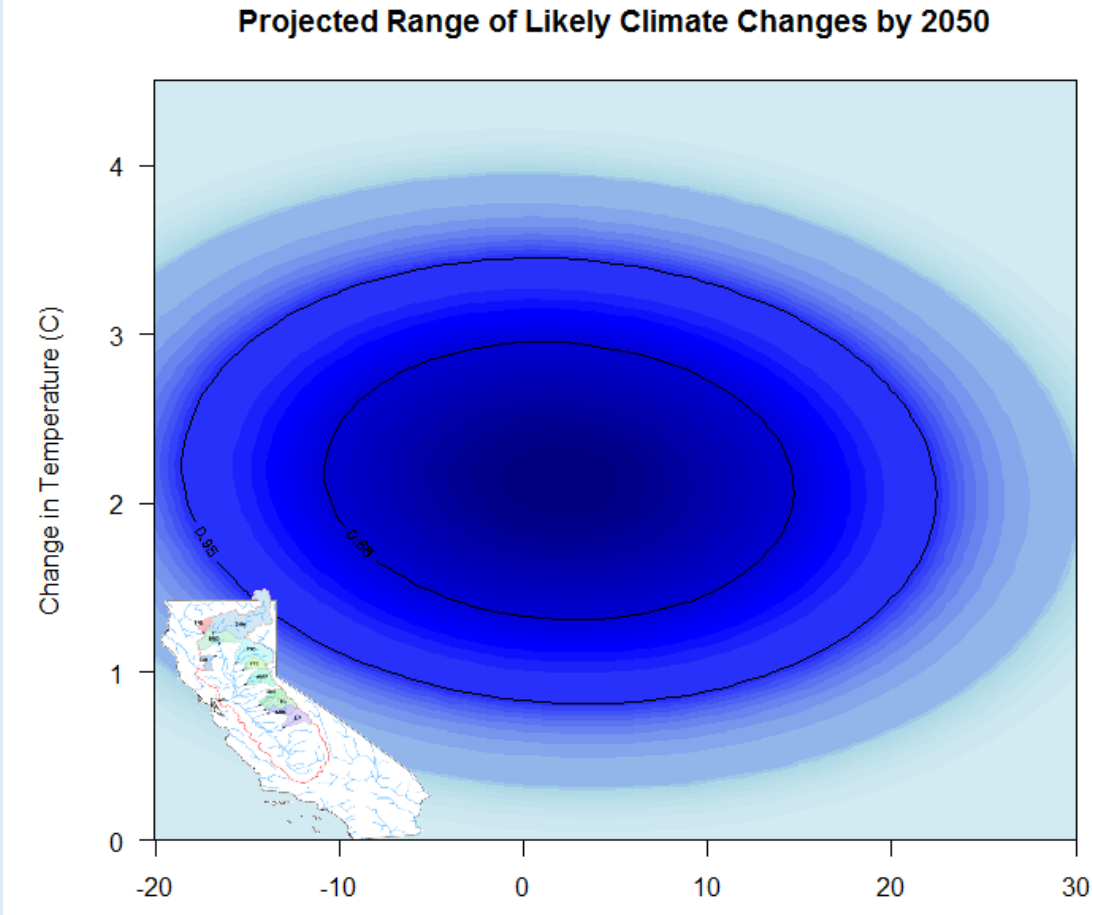

Percent Change in Average Annual SWP Deliveries
Percent Change
100
50
0
-50
-100
Change in Temperature (C)
0
1
2
3
4
-20
-10
0
10
20
30
Precipitation (Percent Change from Historic/Baseline)
0

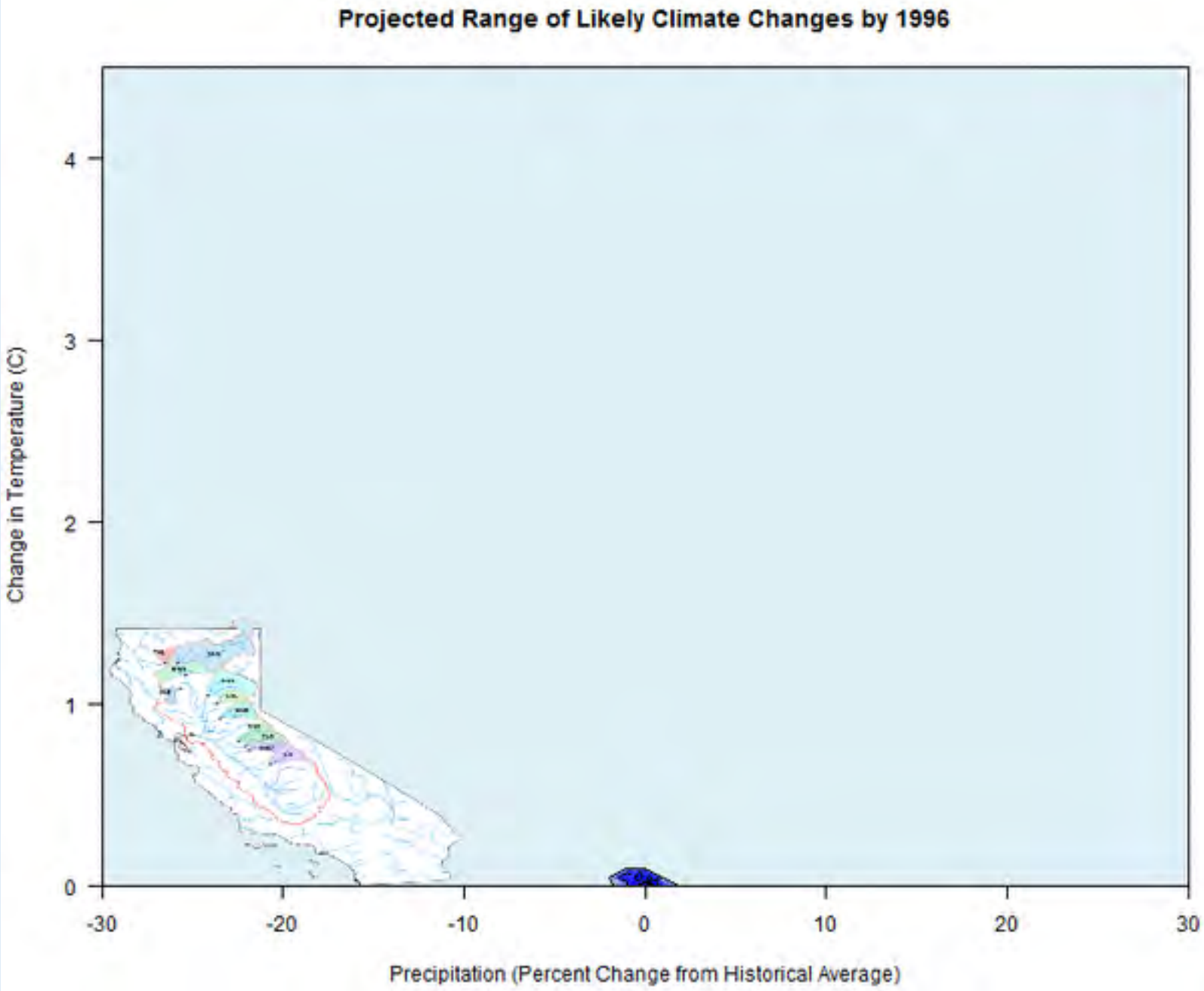
Global Climate Projections

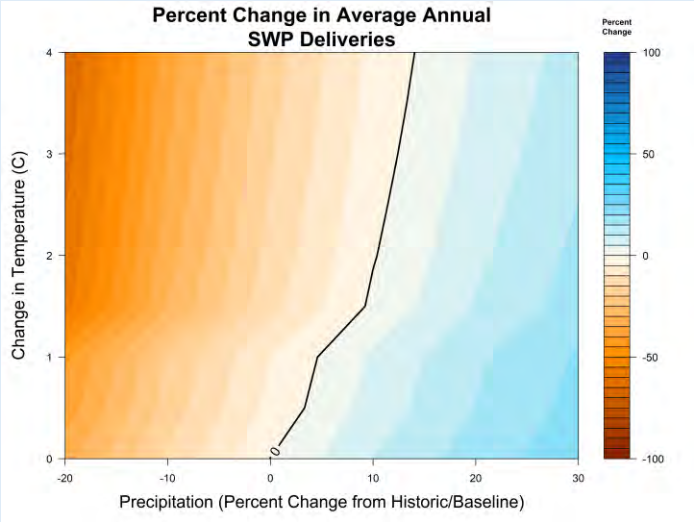


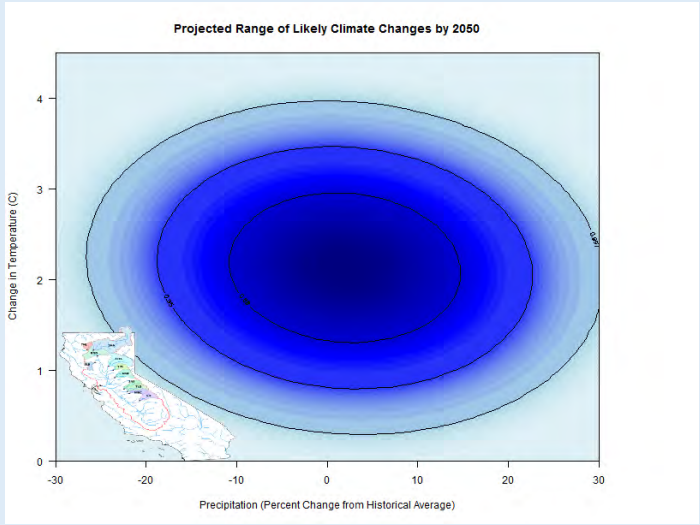
Intergovernmental Panel on Climate Change Coupled Model Intercomparison Project (CMIP5)

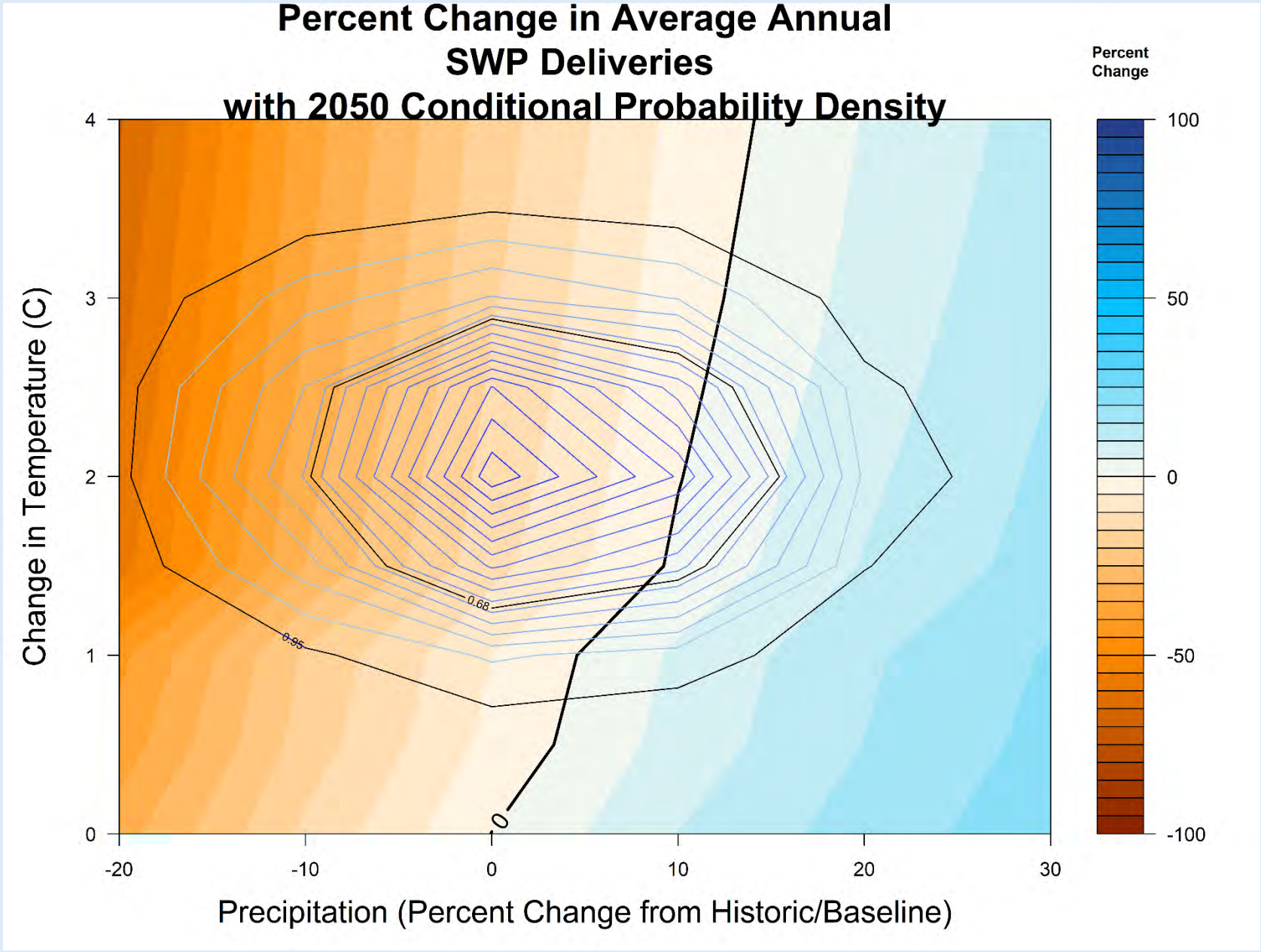
32 different models from research groups from around the world




Projected Range of Likely Climate Changes by 1996
Change in Temperature (C)
0
1
2
3
4
-30
-20
-10
0
10
20
30
Precipitation (Percent Change from Historical Average)

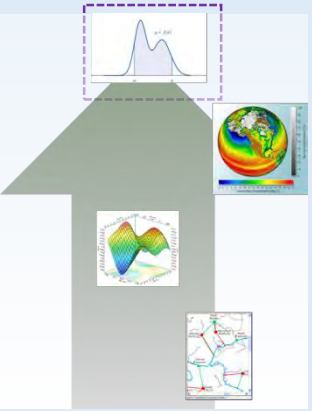

Percent Change in Average Annual SWP Deliveries
Percent Change
100
50
0
-50
-100
Change in Temperature (C)
0
1
2
3
4
-20
-10
0
10
20
30
Precipitation (Percent Change from Historic/Baseline)


Projected Range of Likely Climate Changes by 2050
Change in Temperature (C)
0
1
2
3
4
-30
-20
-10
0
10
20
30
Precipitation (Percent Change from Historical Average)

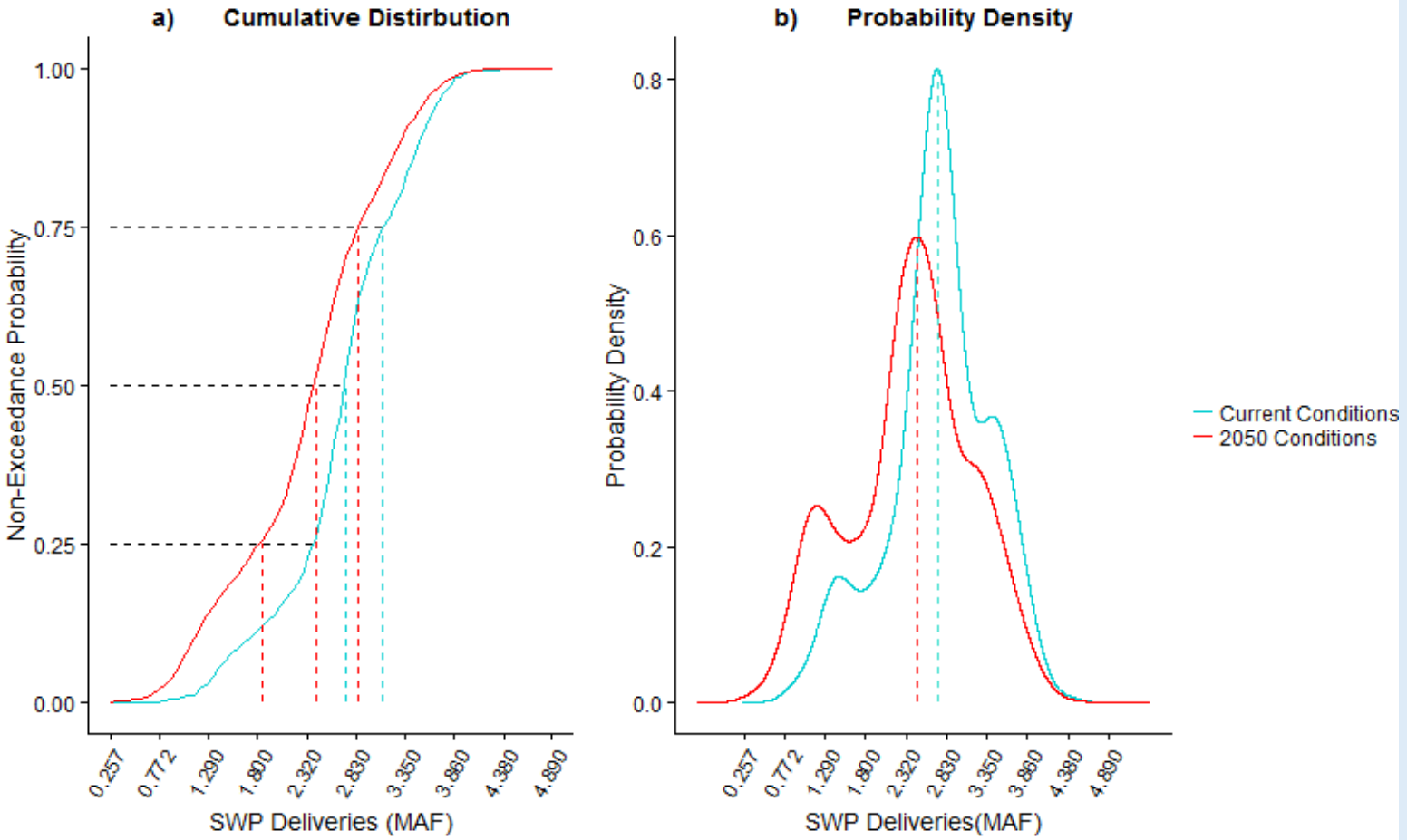

Percent Change in Average Annual
SWP Deliveries
with 2050 Conditional Probability Density
Percent
Change
100
50
0
-50
-100
Change in Temperature (C)
0
1
2
3
4
-20
-10
0
10
20
30
Precipitation (Percent Change from Historic/Baseline)
0.68
0.95
0

Performance Metric	GCM-Based Probability that Mid-Century Performance will be inferior to Current Performance
North-of-Delta Storage	
Total NOD April Storage	65%
Total NOD Carryover Storage	95%
Shasta Carryover Storage	97%
Oroville Carryover Storage	95%
Folsom Carryover Storage	99%
Trinity Carryover Storage	87%
Net Delta Outflow	
Winter	63%
Spring	65%
Summer	21%
Fall	40%
Annual Delta Exports	93%

Source: Pre-publication CCC4A, "Climate Change Risks Faced by the California Department of Water Resources" Schwarz et al. 2018



Shift in SWP Deliveries Current to 2050 Conditions



	P25	P50	P75
Current Conditions	2.42	2.73	3.12
2050 Conditions	1.85	2.42	2.86

	Mode
Current Conditions	2.71
2050 Conditions	2.45

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